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# Energy efficient biogas upgrading by anaerobic hydrolysis

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# Energy efficient biogas upgrading by anaerobic hydrolysis

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## **BioEnergy IV:**

Innovations in Biomass Conversion for Heat & Power, Fuels and Chemicals

June 9-14, 2013

Basiliani Resort, Otranto, Italy

**Rolf Jung**

Fraunhofer UMSICHT, Institute branch Sulzbach-Rosenberg

# Our motivation ...



## Energy conversion and storage



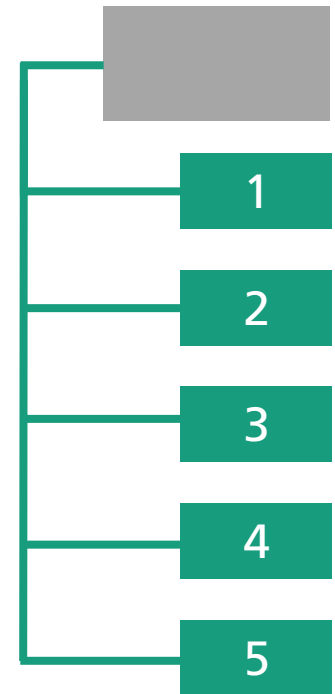
## Raw and functional materials

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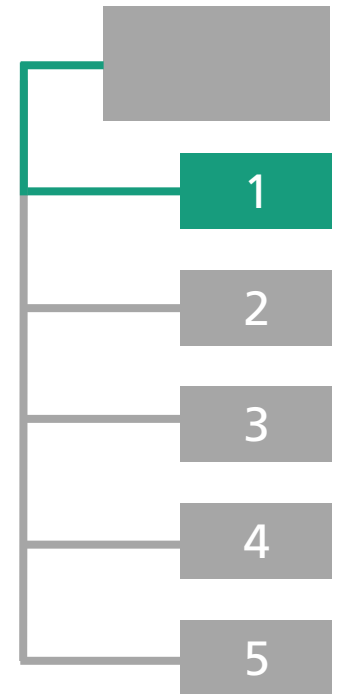
# AGENDA

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- Introduction
- Background
- Materials and Methods
- Results and Discussion
- Conclusions



# INTRODUCTION

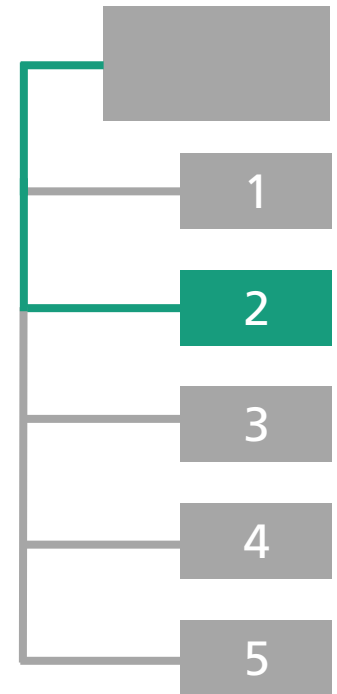


# Introduction

## *Motivation*

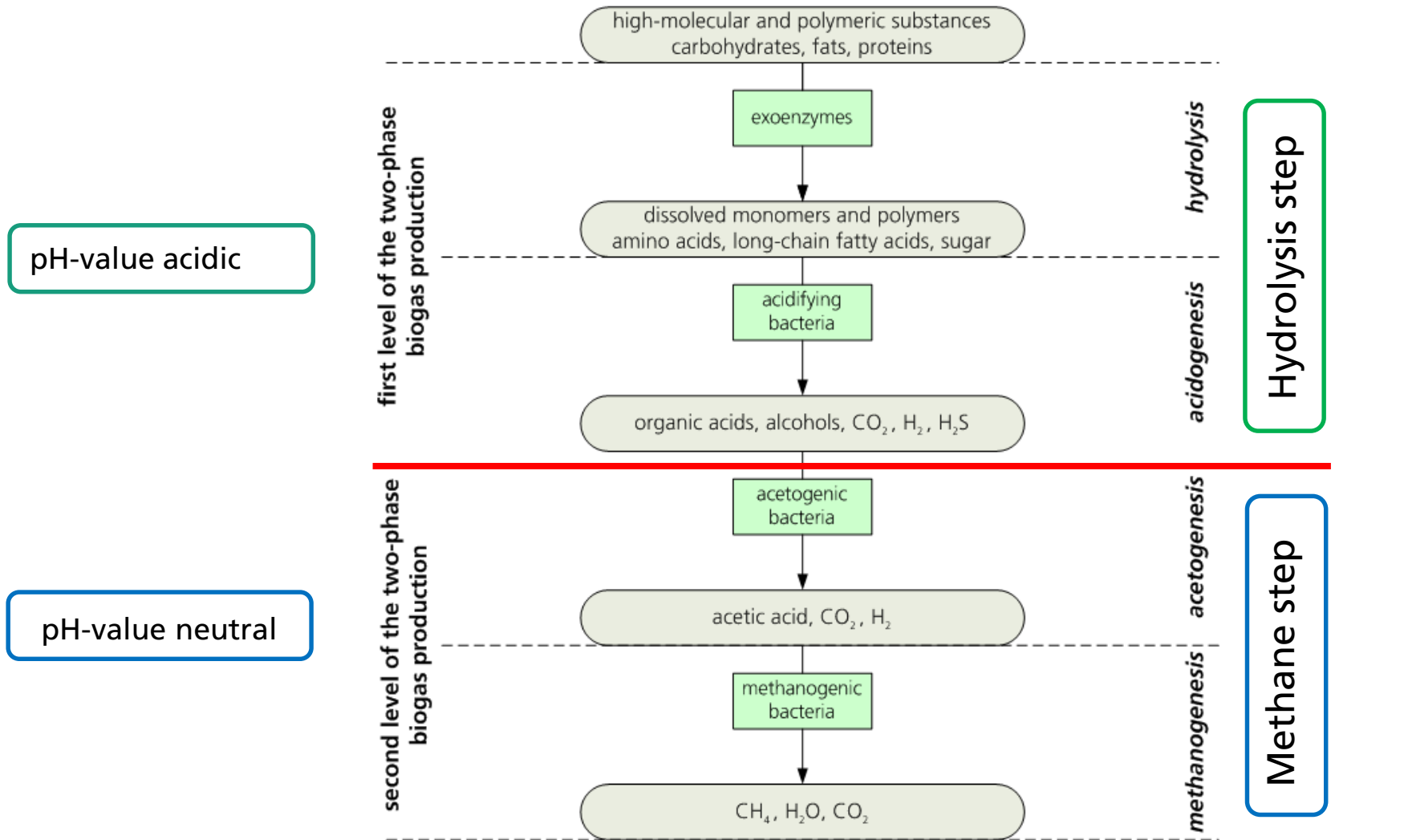
- Strong growth of biogas plants
- Biomethane can be stored or fed into the public natural gas grid
- Efficient energy usage via public grid
- Biogas upgrading is an energy intensive process
- Carbon dioxide reduction before biogas upgrade increase efficiency and decline costs

# BACKGROUND



# Background

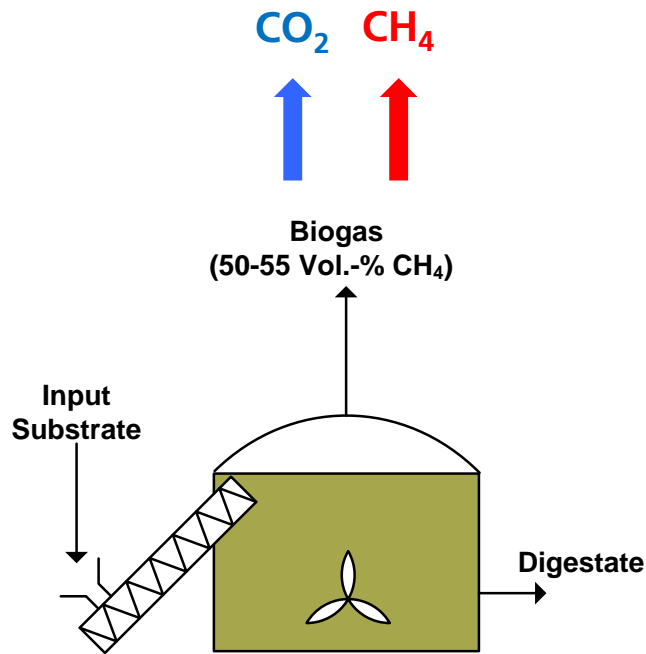
## Anaerobic process steps



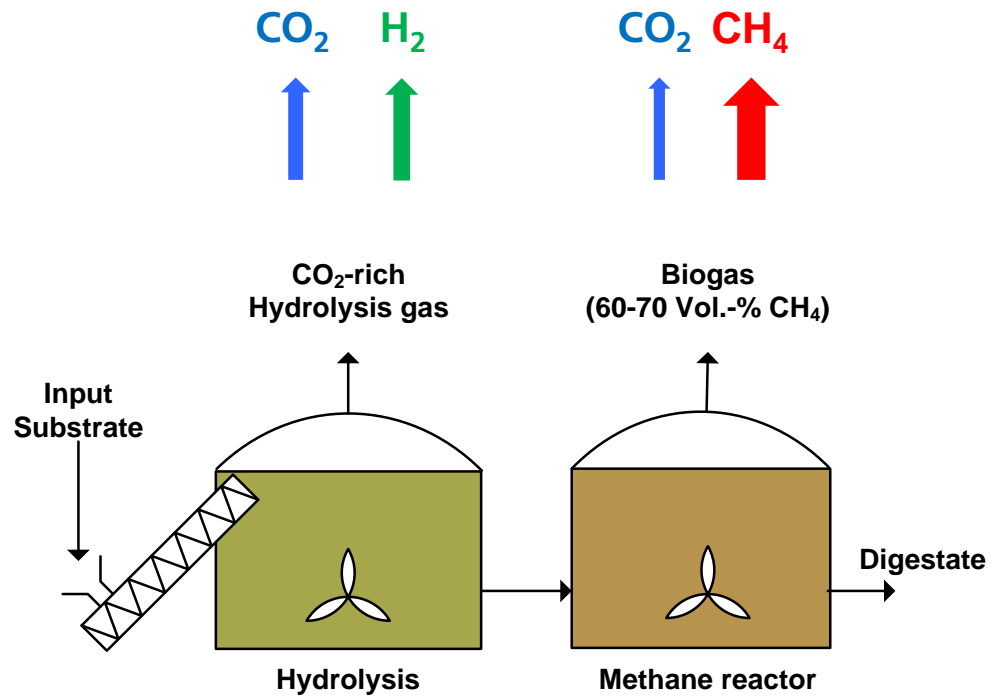


# Background

## *One-phase and two-phase digestion*



One-phase digestion



Two-phase digestion

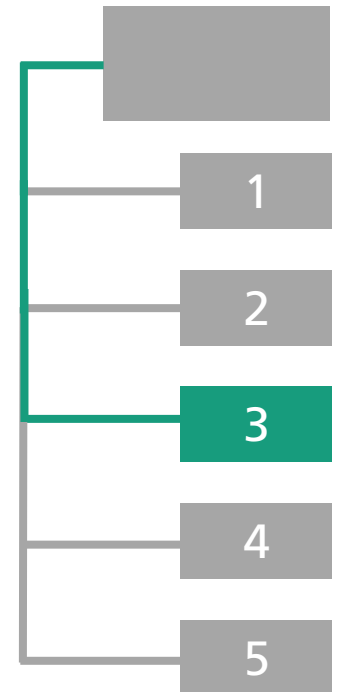
# Background

## *Process key parameters for hydrolysis step*

- Hydraulic retention time (HRT)
- Temperature
- pH-value
- Organic loading rate

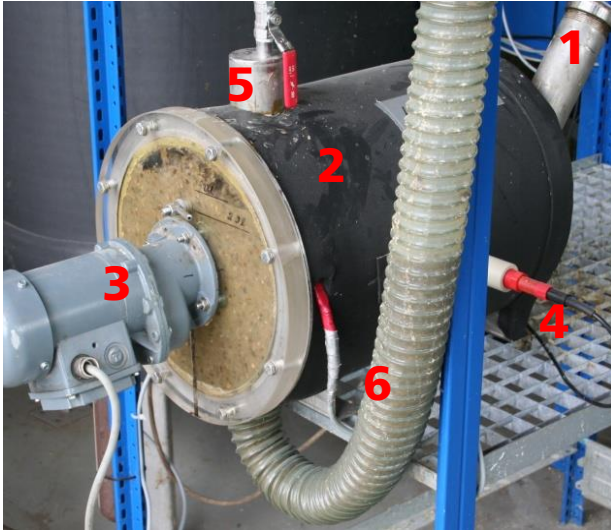


# MATERIALS AND METHODS



# Materials and methods

## *Experimental setup*



Hydrolysis reactor

$$V_R = 22 \text{ l}$$

- (1) Input
- (2) Reactor
- (3) Stirrer
- (4) pH value
- (5) Gas outlet
- (6) Output



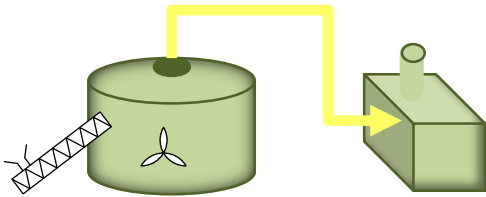
Methane reactors

$$V_R = 45 \text{ l}$$

# Materials and methods

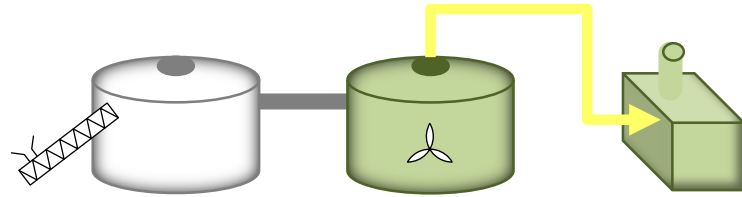
## Experimental parameters

### One-phase digestion



- Substrate: maize silage
- Temperature: 39 °C
- Retention time: 20 d
- Organic loading rate: 1 kg<sub>oDM</sub>/(m<sup>3</sup>·d)

### Two-phase digestion

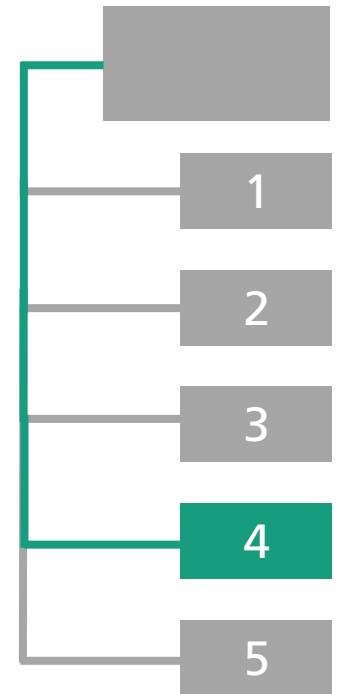


- Substrate: maize silage
- Temperature: 39 °C
- **Hydrolysis phase:**
- Retention time: 5 d
- Organic loading rate: 38 kg<sub>oDM</sub>/(m<sup>3</sup>·d)

#### **Digestion phase:**

- Retention time: 15 d
- Organic loading rate: 3 kg<sub>oDM</sub>/(m<sup>3</sup>·d)

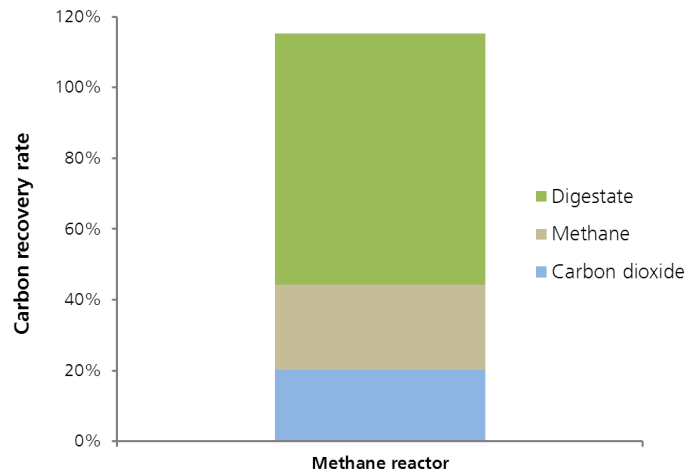
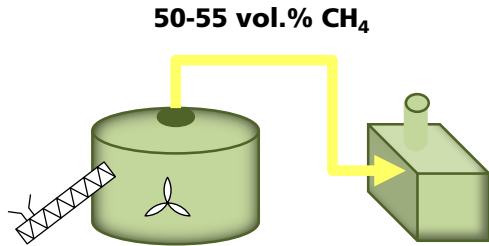
# RESULTS AND DISCUSSION



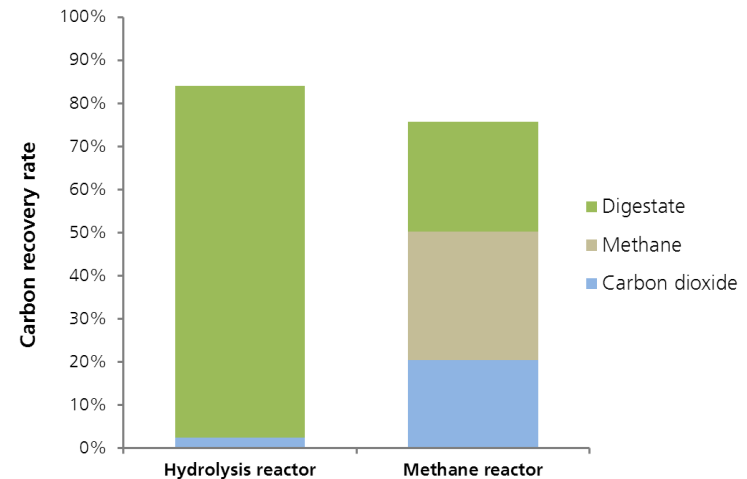
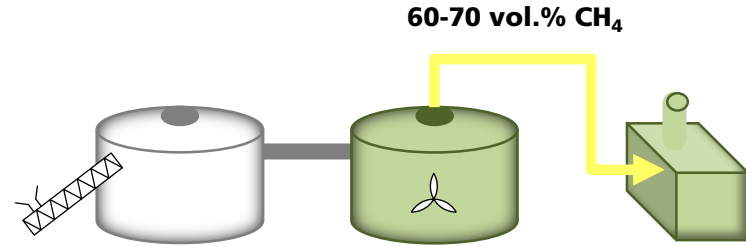
# Results and discussion

## *experimental trials – carbon mass balance*

### One-phase digestion

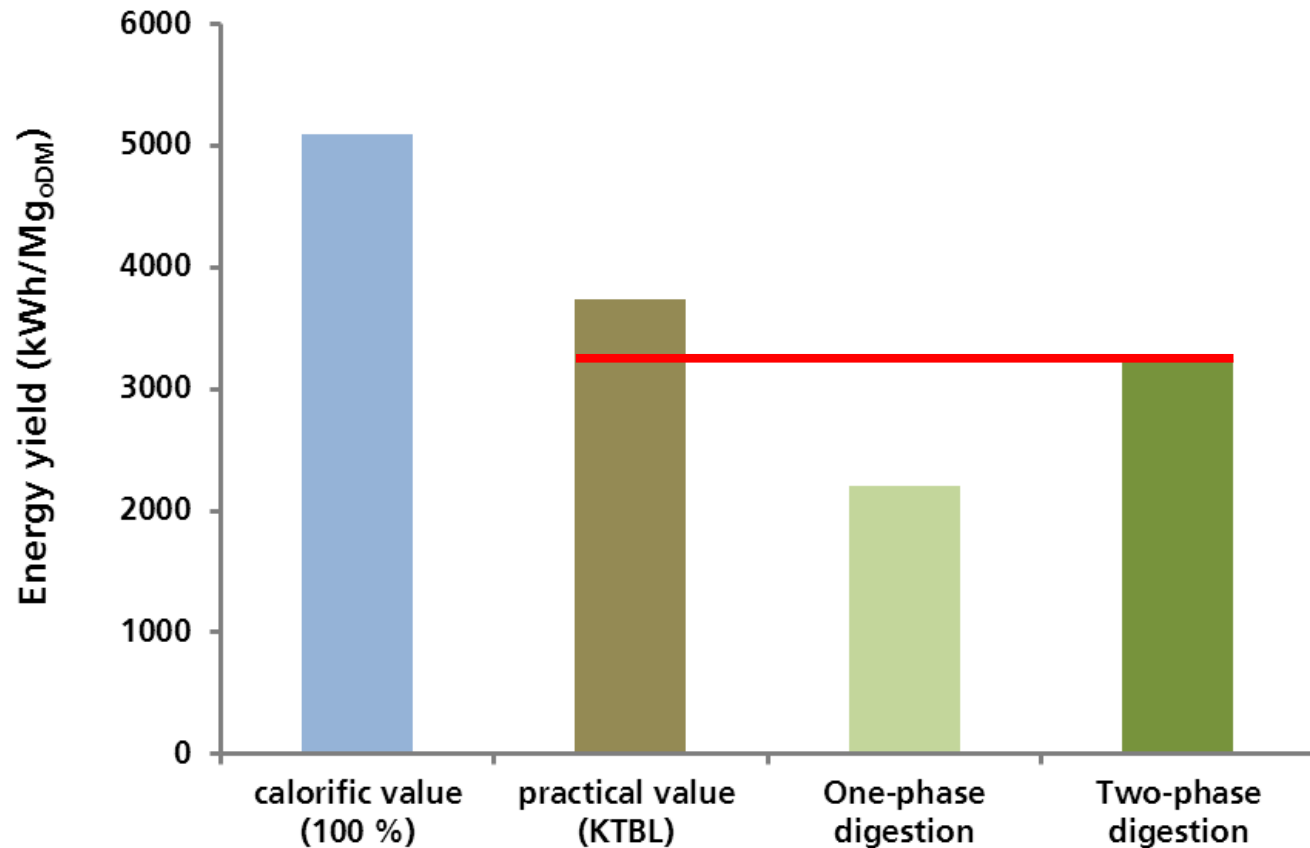


### Two-phase digestion



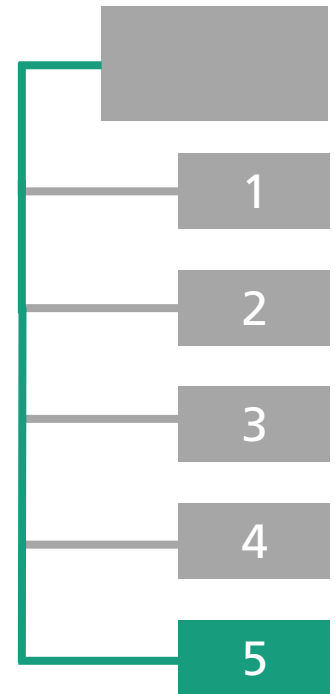
# Results and discussion

## *Comparison of energy yield gas*





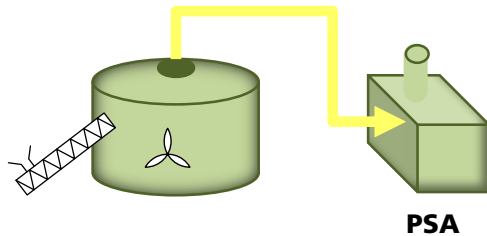
# CONCLUSIONS



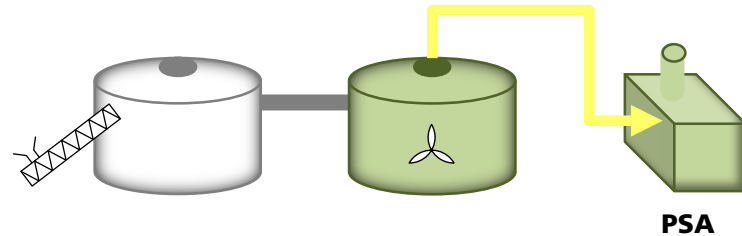
# Conclusions

## Assets and drawbacks

### One-phase digestion



### Two-phase digestion



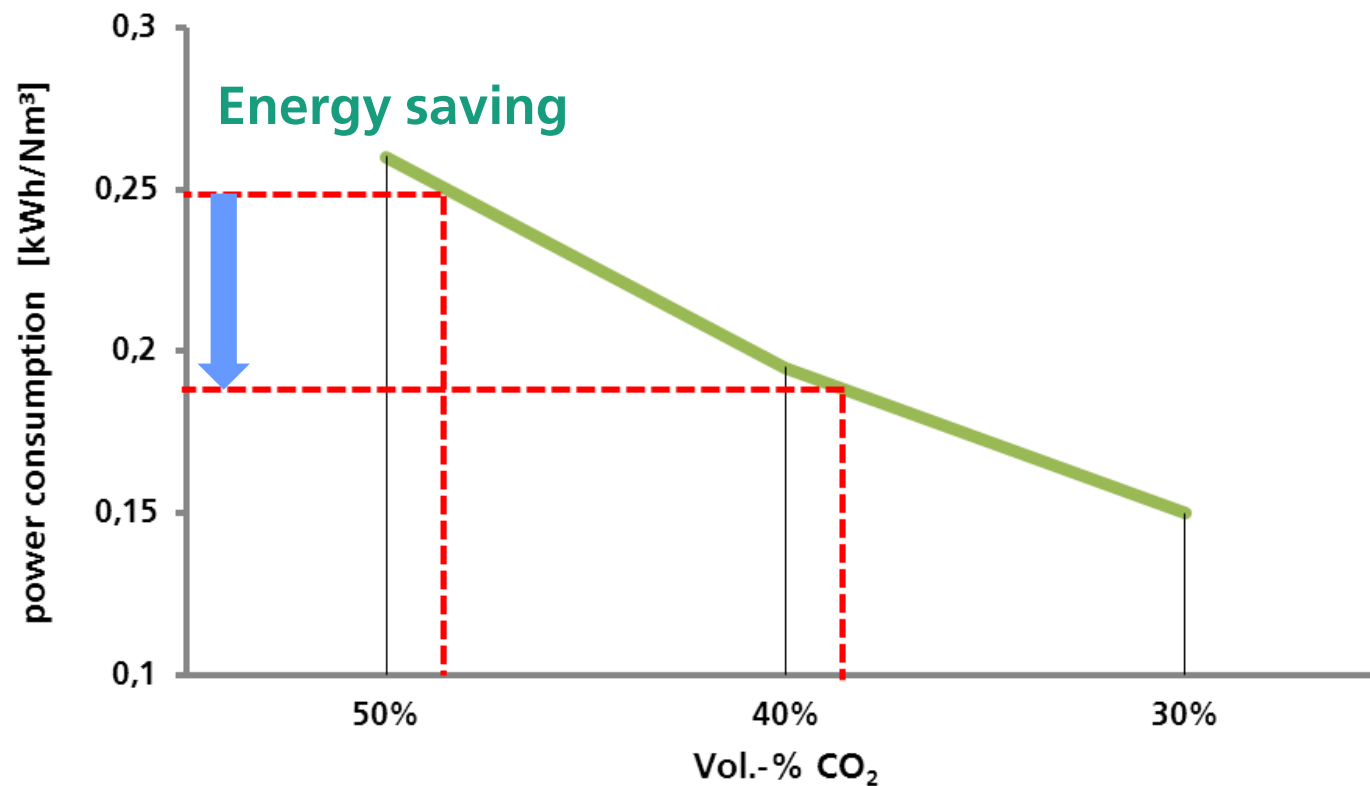
- Increase of methane concentration
- Lower energy costs for biogas upgrading
- Higher investment costs
- Energy loss by hydrolysis gas ( $H_2$ )



# Conclusions

## Outlook

- Comparison of power consumption for biogas upgrade



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# Energy efficient biogas upgrading by anaerobic hydrolysis

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Contact:

Thank you very much!



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# Energy efficient biogas upgrading by anaerobic hydrolysis

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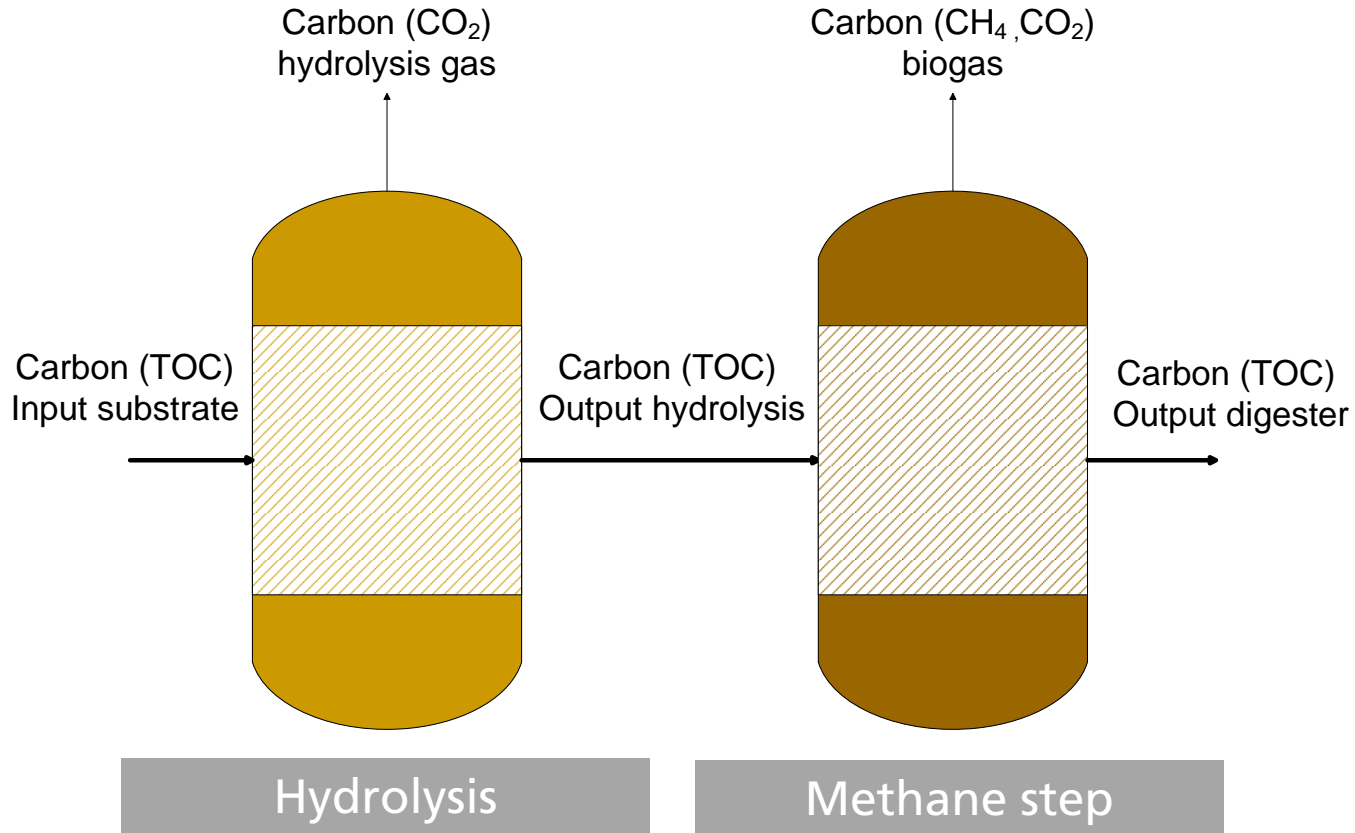
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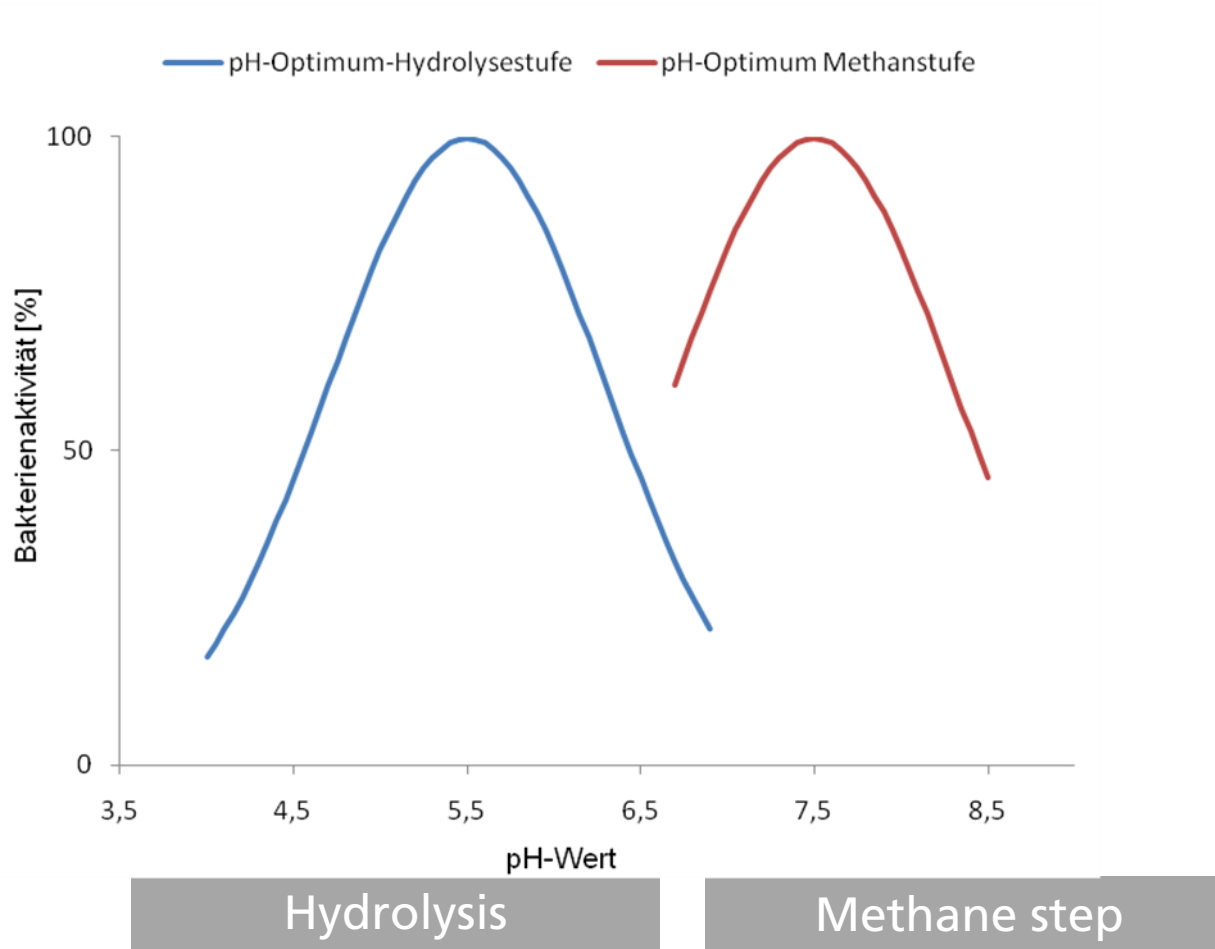
# Material and methods

## *Carbon mass balance*



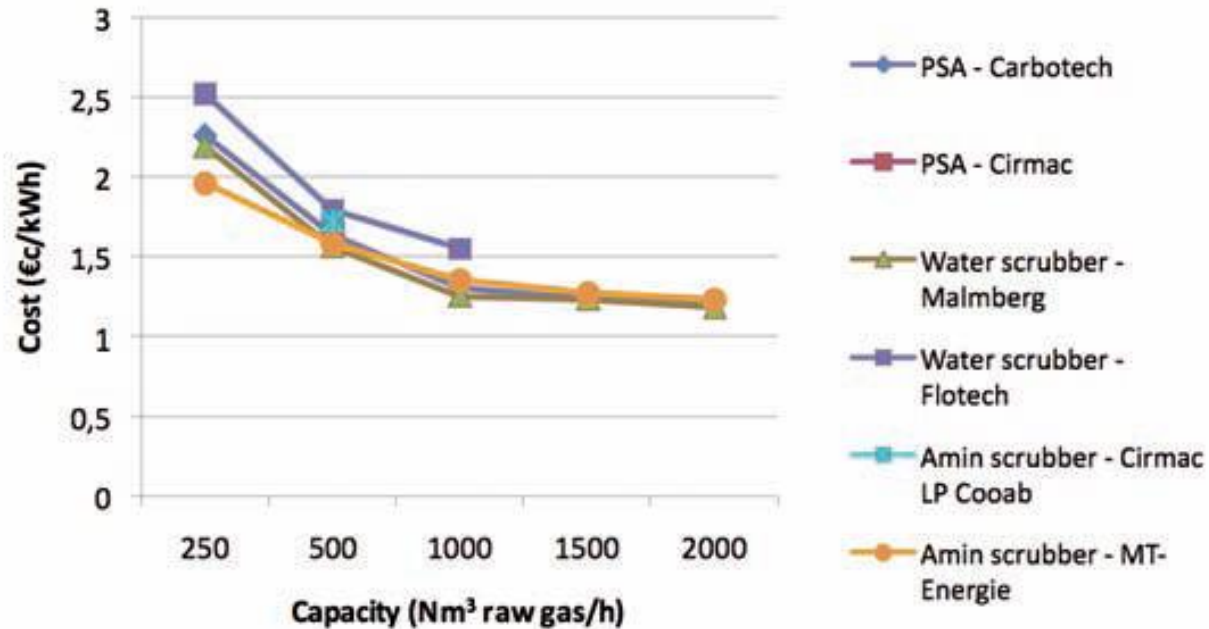
# Material and methods

## *pH and activity microorganism*



# Conclusions

XXX



Estimated cost of biogas upgrading using different technologies (Urban et al.2008).